

Developing Effective Ecosystem Monitoring Strategies for Military Activities in Deserts: Yuma Proving Ground

**Dirt, Shrubs, and Soil
Hydrology in Desert
Environments**

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Yuma Proving Ground



Developing Effective Ecosystem Monitoring Strategies for Military Activities in Deserts: Preliminary Results from Yuma Proving Ground

Funding Provided by:

SERDP SEED Grant

ARO Research Grant

Legacy Program

Management of Desert Ecosystems

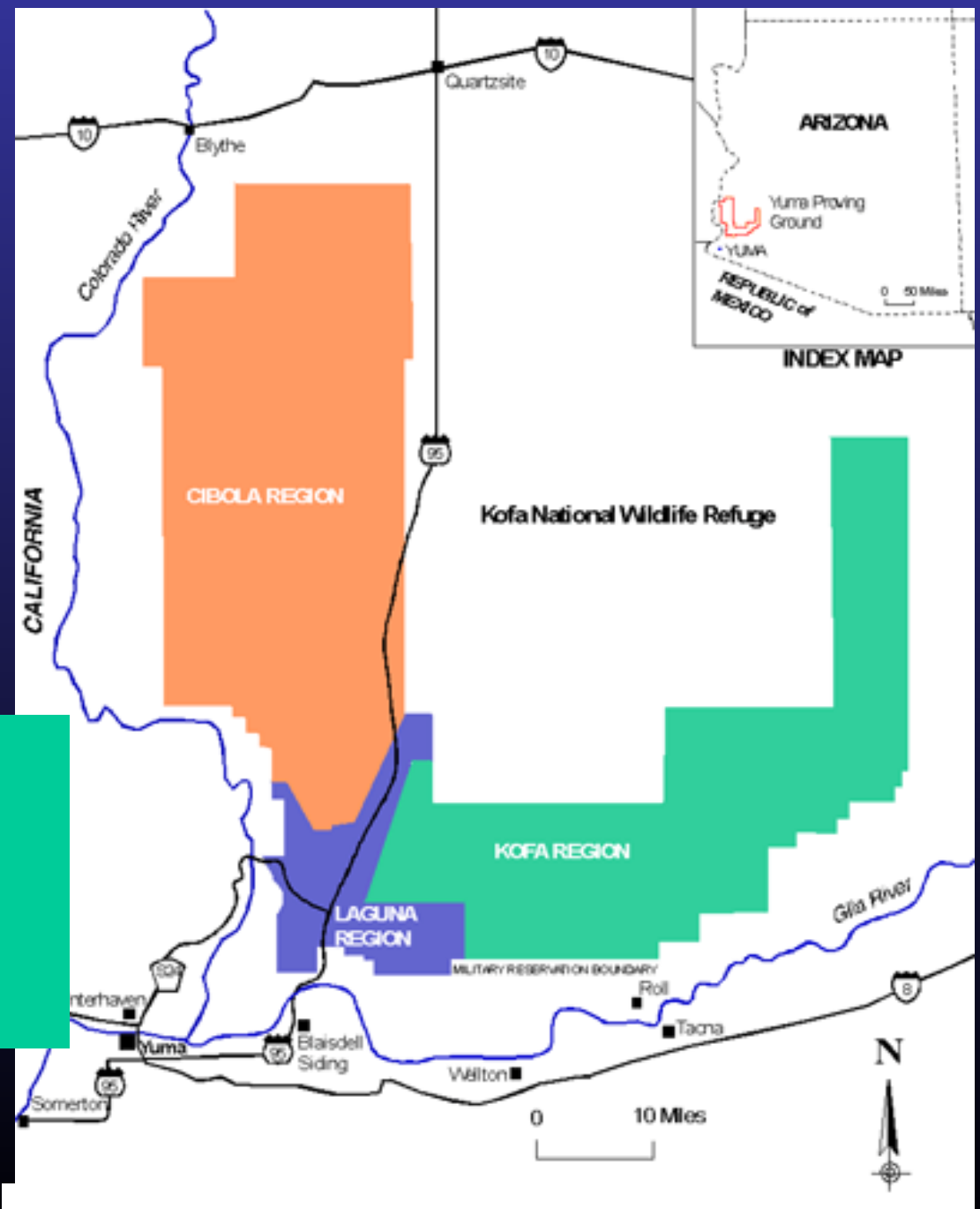
- ❖ 70% of DoD lands in dryland regions
- ❖ New weapons/tactics require additional operational space
- ❖ Increased public interest in desert lands
- ❖ Deserts susceptible to climatic change and land use impacts
- ❖ Many gaps in scientific knowledge of desert ecosystems, especially linkage among landscape, climate, and vegetation processes

Outline

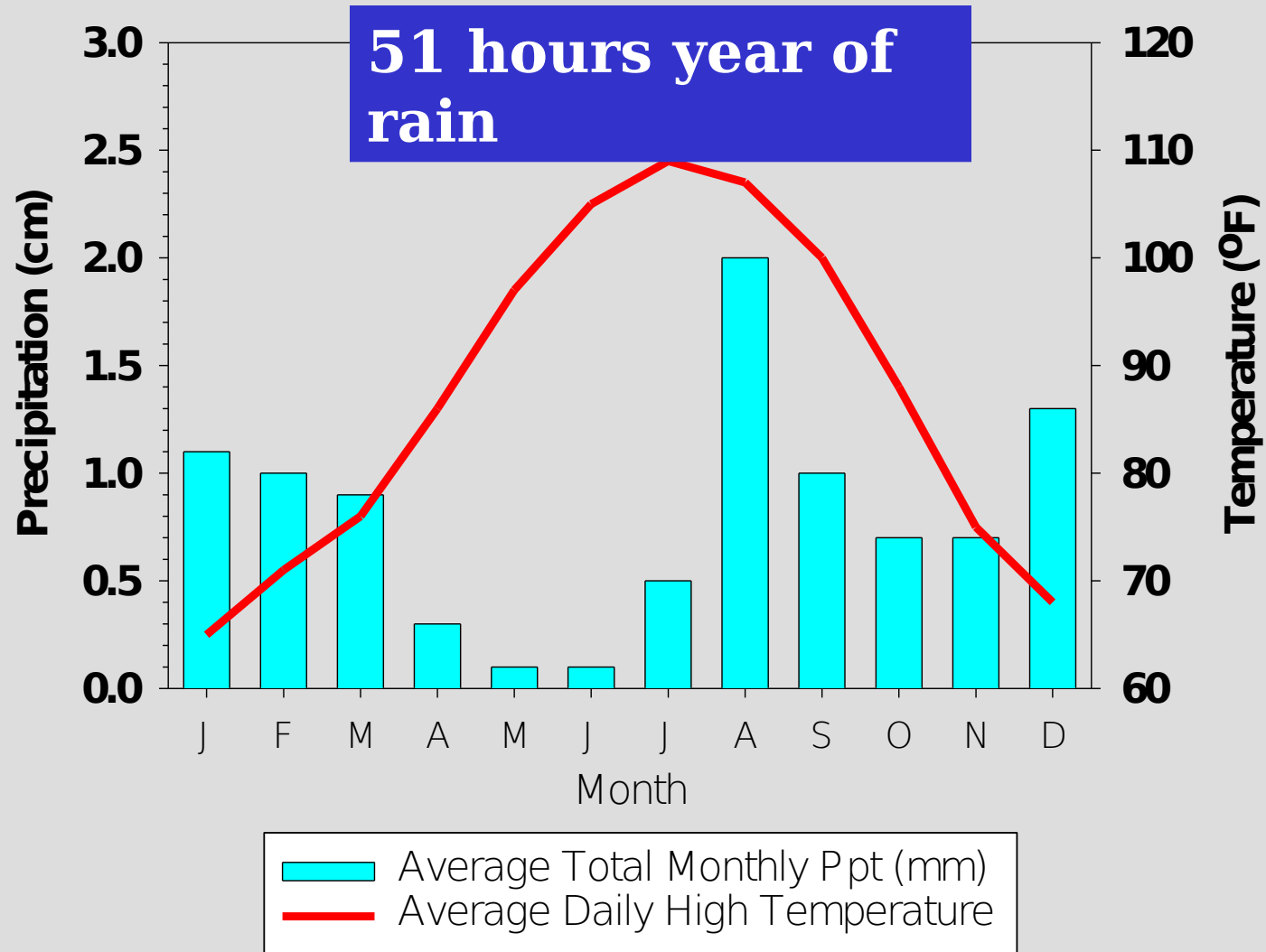
- ❖ **Physical Setting**
- ❖ **The Problem:** Develop effective ecosystem monitoring strategies.
- ❖ **Solution:** Determine linkage between water and vegetation dynamics
- ❖ **Project:** Integration of soils, landscape position, vegetation, and hydrology for ecosystem management:
- ❖ **Results**

Physical 1 Setting

Yuma Proving Ground

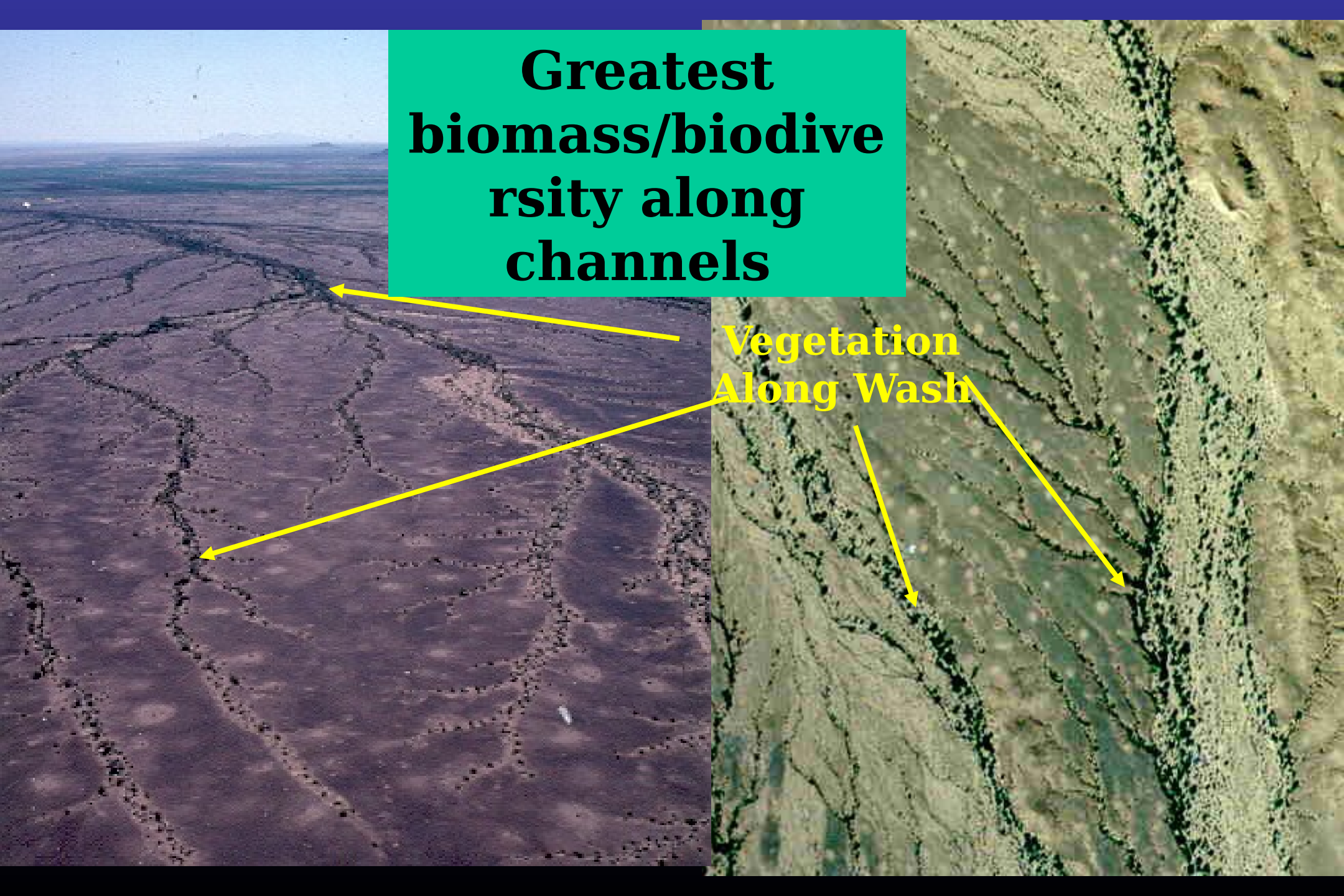


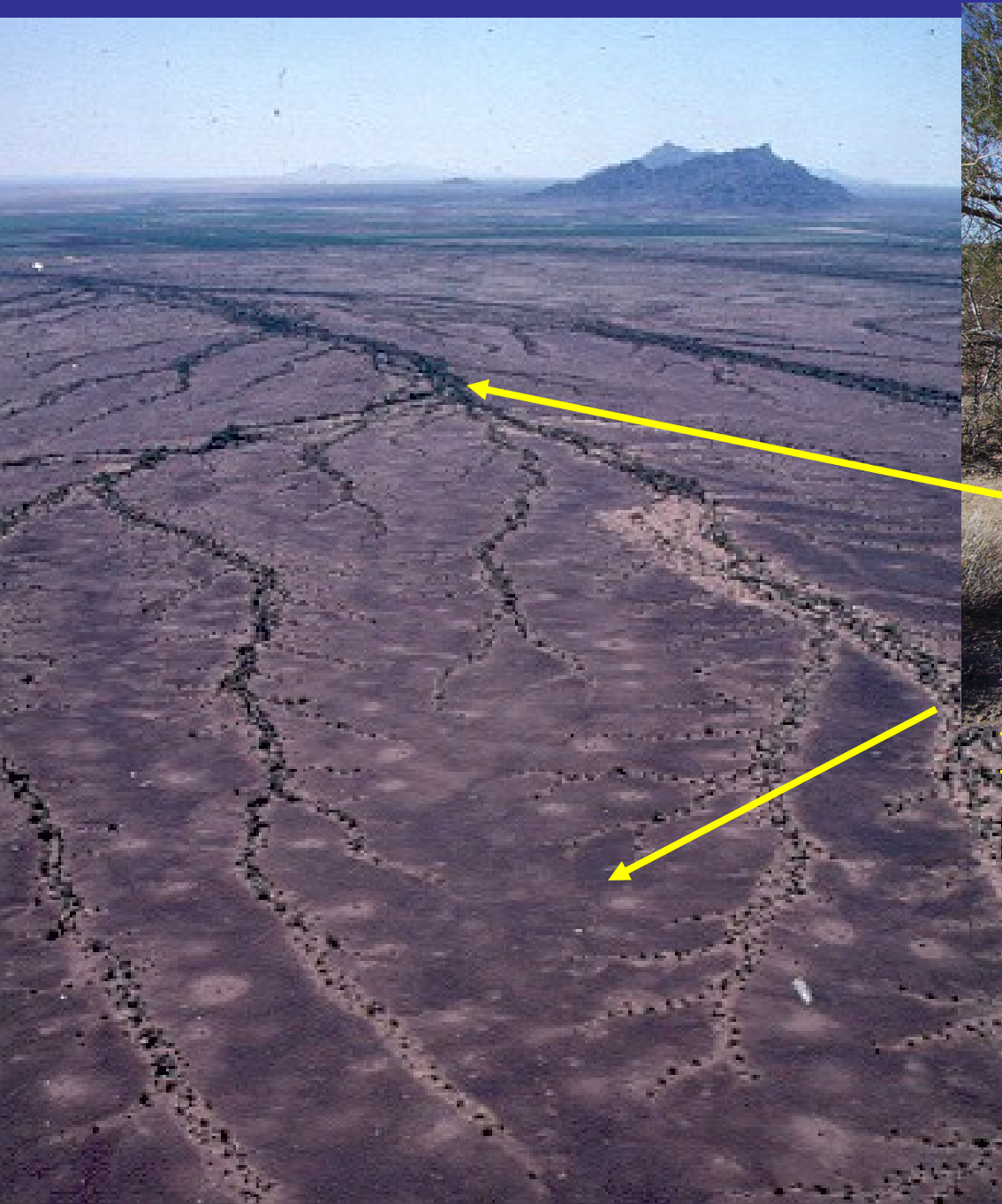
Average rainfall too low to directly support shrubs and trees on most soils



**Greatest
biomass/biodive
rsity along
channels**

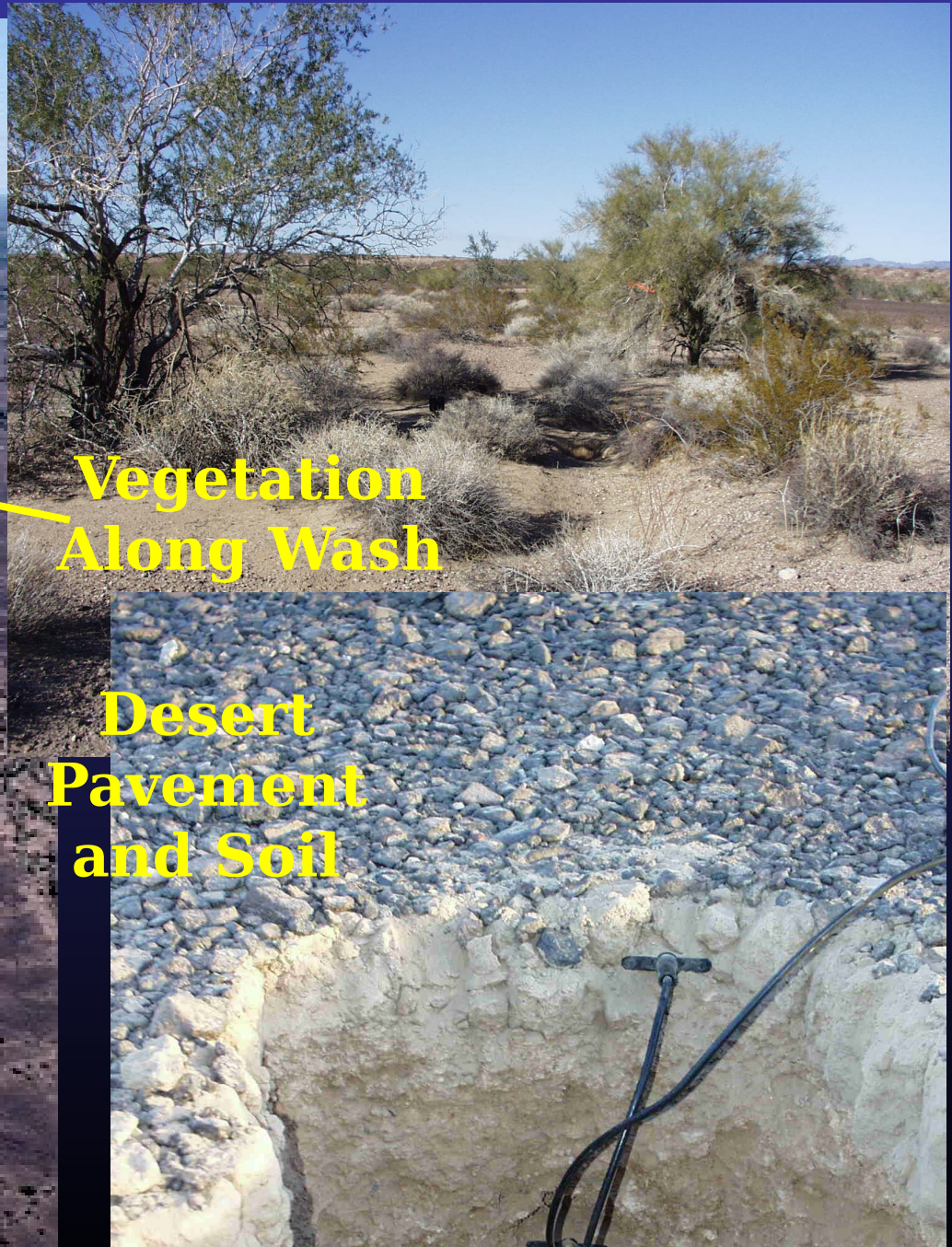
**Vegetation
Along Wash**





**Vegetation
Along Wash**

**Desert
Pavement
and Soil**



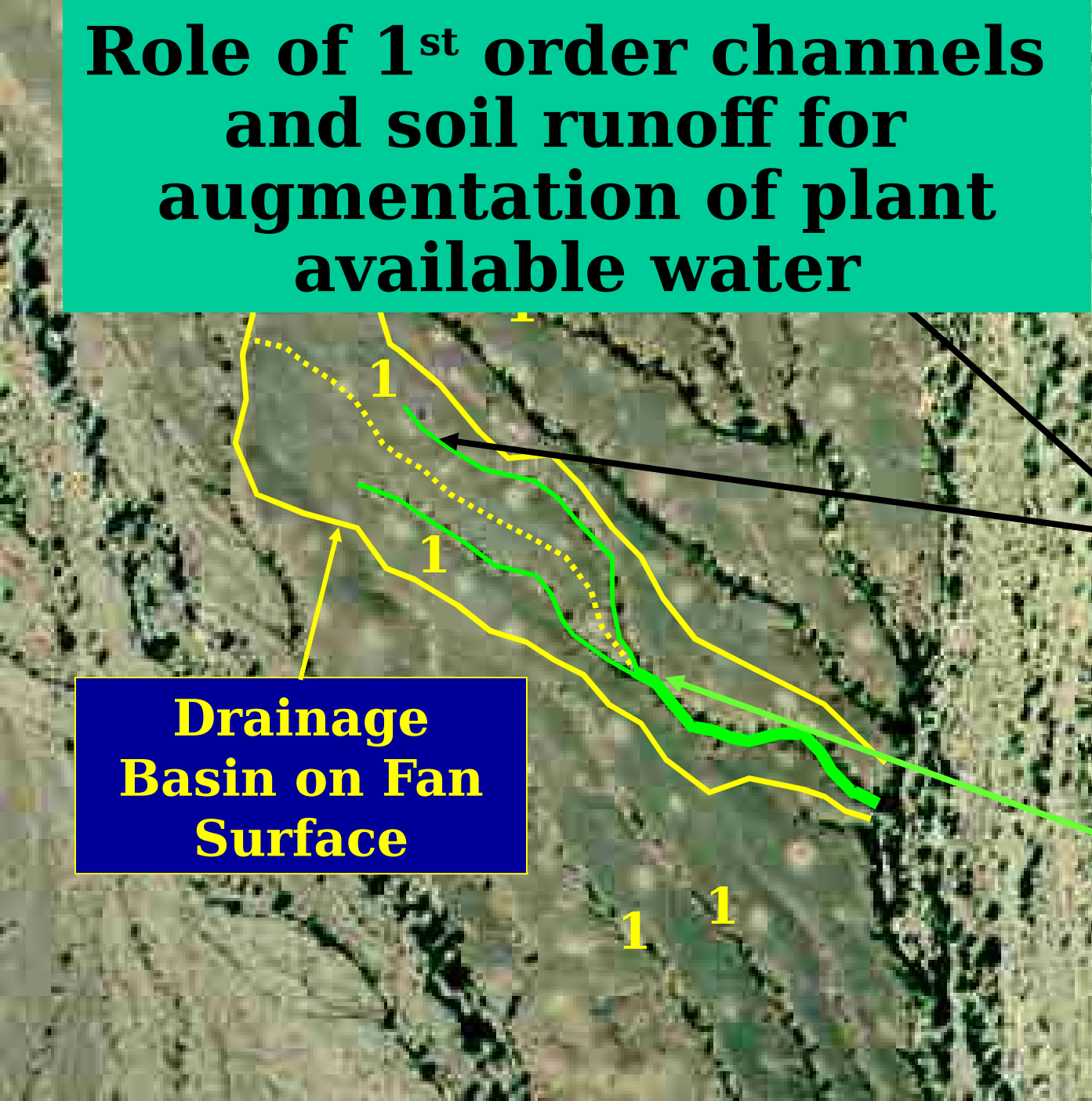
Role of 1st order channels and soil runoff for augmentation of plant available water

1st Order Channels:

A channel with no tributaries

Vegetation Along Washes on Fan

Drainage Basin on Fan Surface

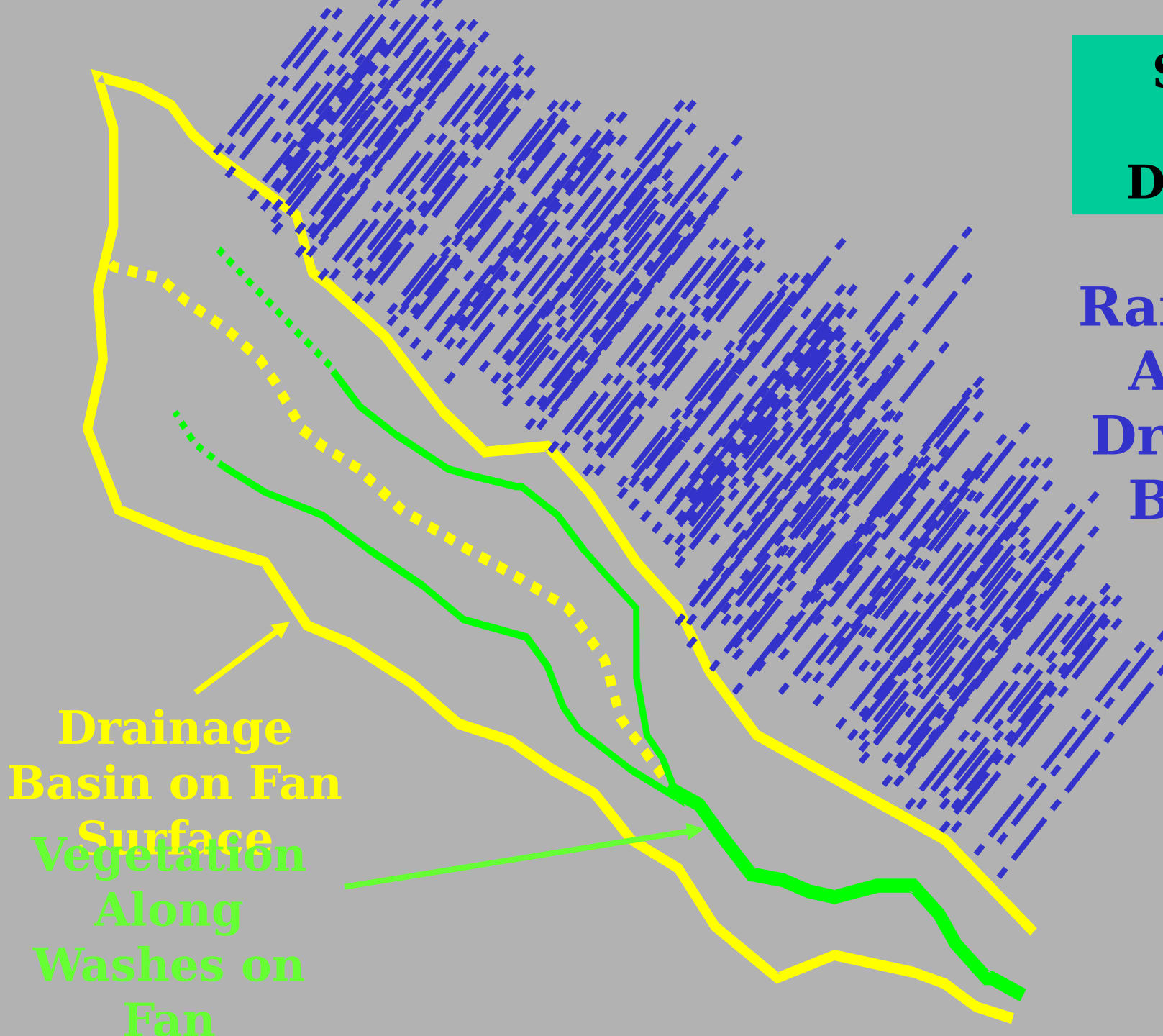


**Surface
Water
Dynamics**

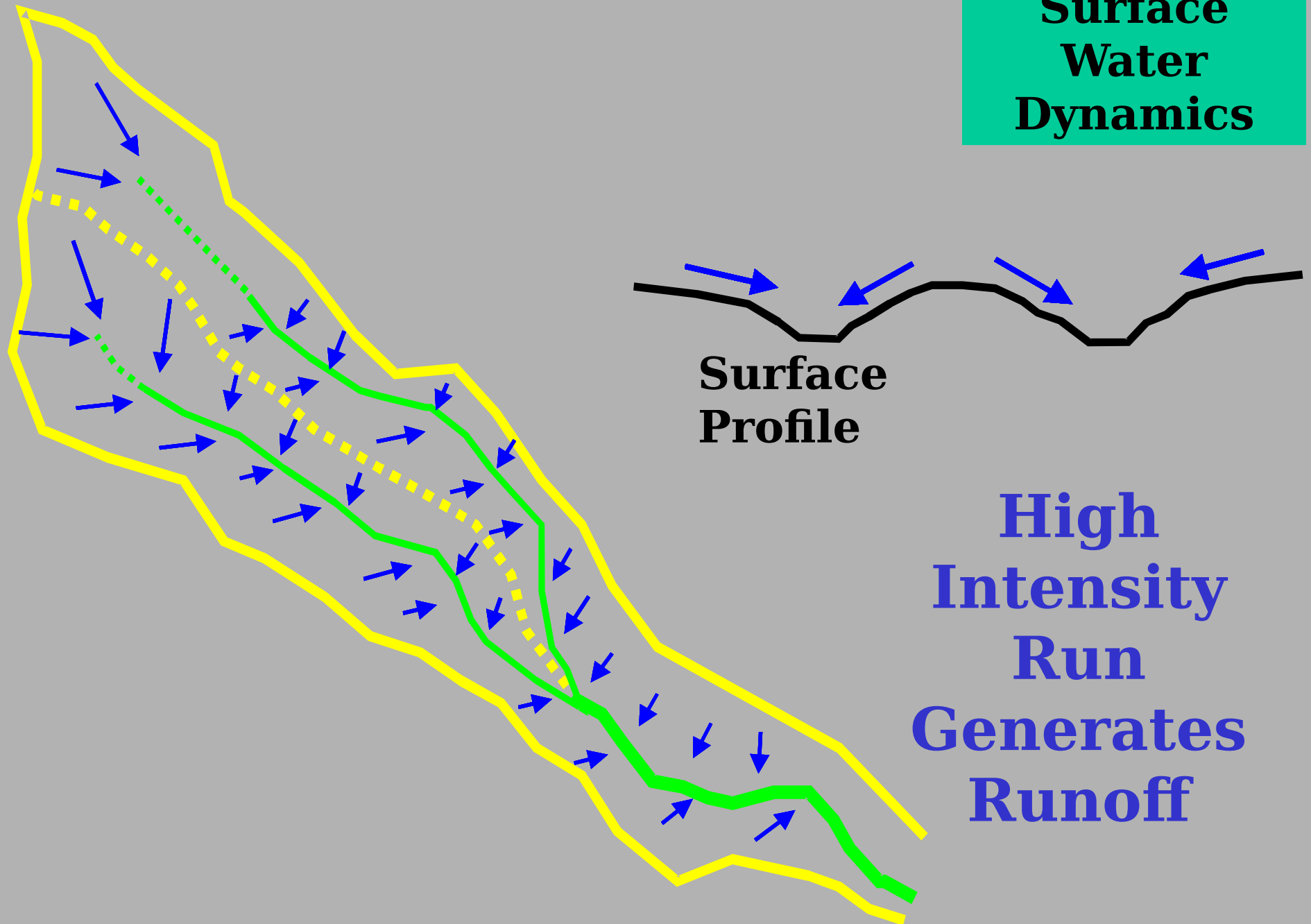
**Rain Falls
Across
Drainage
Basins**

**Drainage
Basin on Fan**

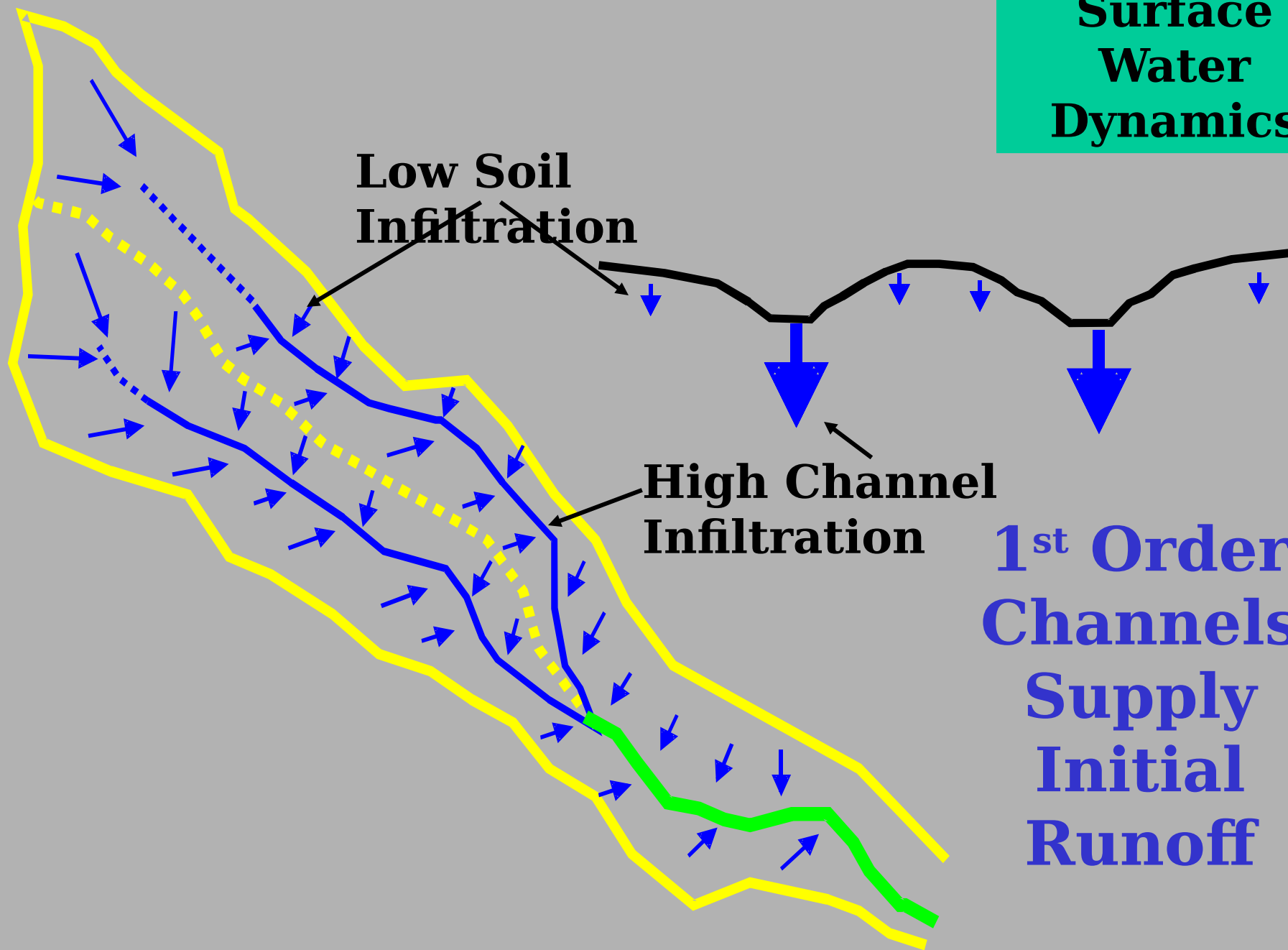
**Vegetation
Along
Washes on
Fan**



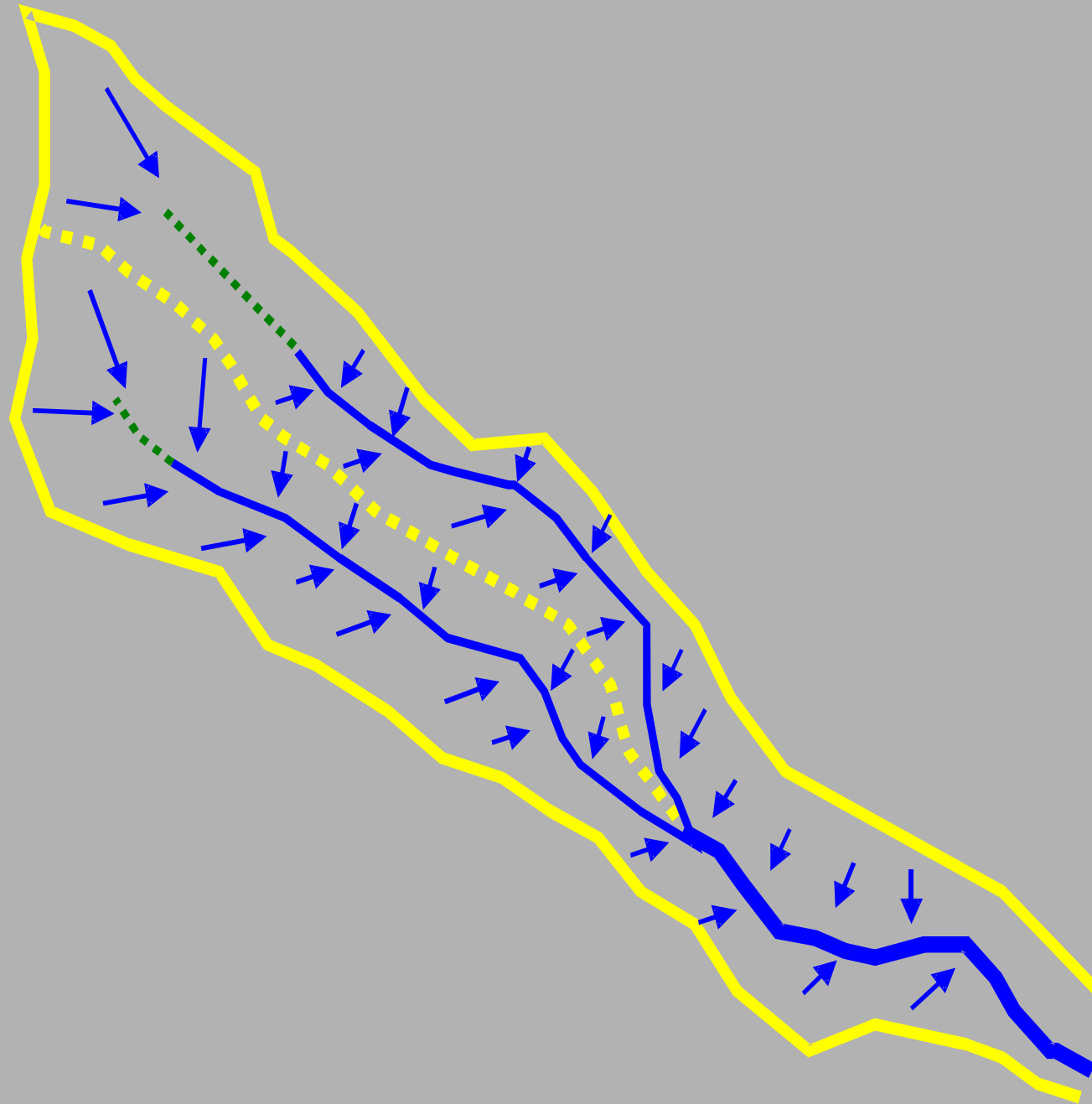
Surface Water Dynamics



Surface Water Dynamics



Surface Water Dynamics



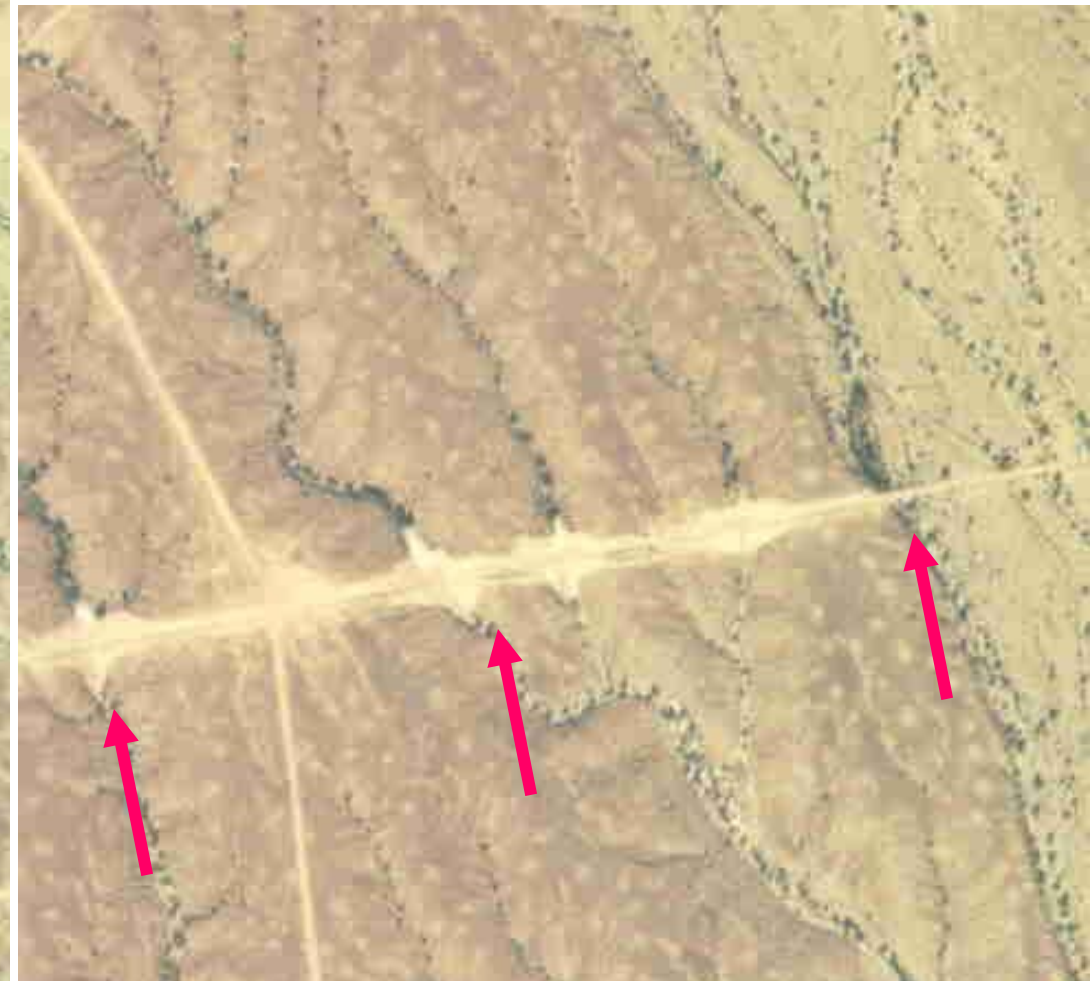
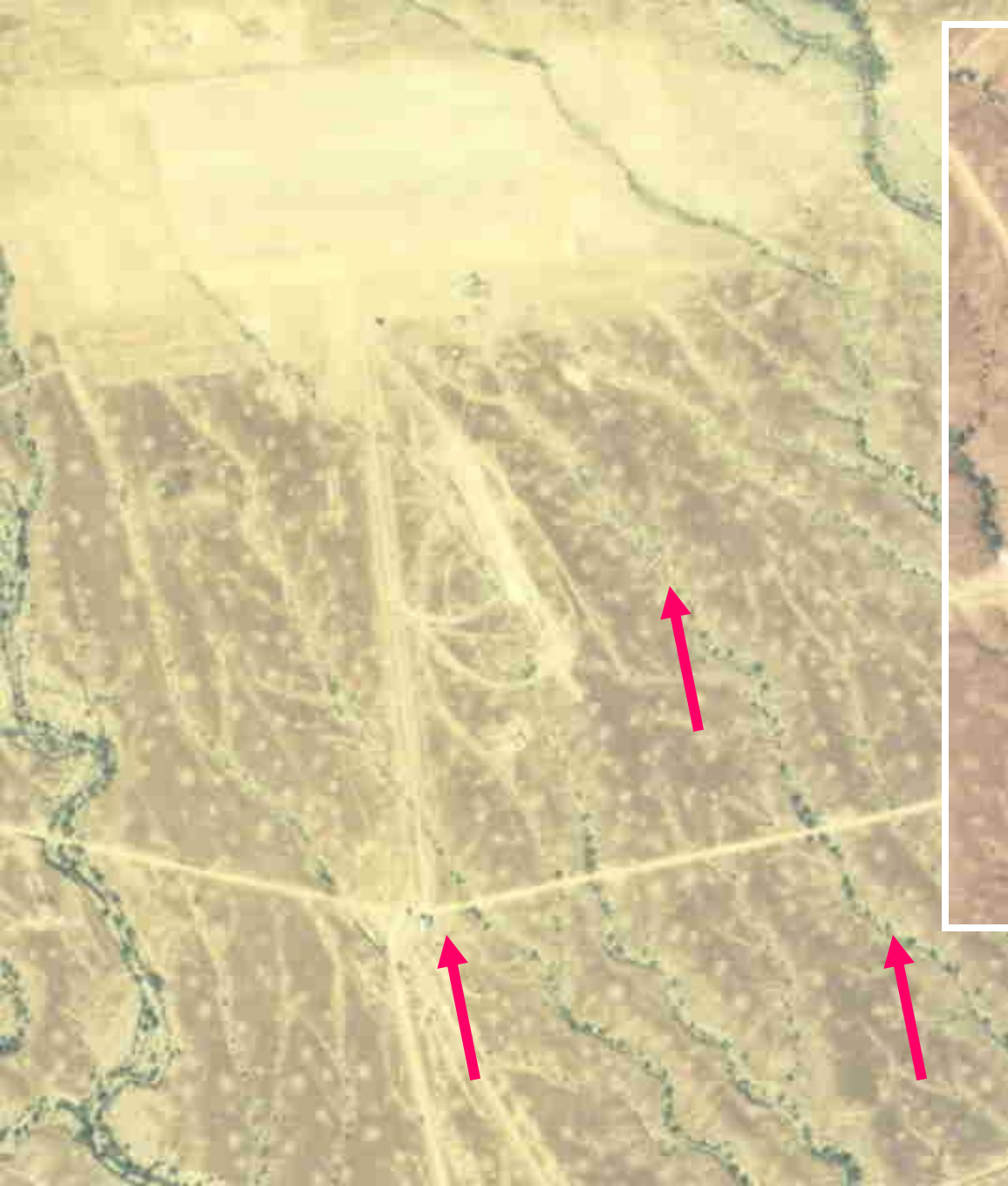
**1st Order
Channels
Supply
Higher
Order
Channels**

The Problem

- ❖ **Disruption of the soil surface and/or blocking of low order drainages will decrease water resources**



**Widespread
disruption of
the soil
surface from**



**Reduction in
Vegetation/Biomass
from Alteration of
Surface Water**

**Roads disrupt
flow of water to
vegetation**

**Upstream:
Abundant
trees/shrubs**



**Downstream:
Impacted
trees/shrubs**

The Problem

- ❖ Disruption of the soil surface and/or blocking of low order drainages will decrease water resources
- ❖ **Evidence for recent (historic ?) decline in vegetation**

LCTA Data suggests a decrease in key shrubs: *A. Dumosa* (bursage) and *L. Tridentata* (creosotebush)

Why? Natural
or Human
Induced????

Abundant Plant
Scars Indicate a
Reduction in
Vegetation is



Pilot Project at YPG: Premise

- ❖ Most water supplied by soil runoff into 1st order channels
- ❖ Change in vegetation along 1st order channels indicates change in water supply
- ❖ Condition of 1st order channels provides an indicator of ecosystem status (esp. larger ecosystems downstream)

Basic Experimental Layout

First-Order Drainage Boundary

Channel

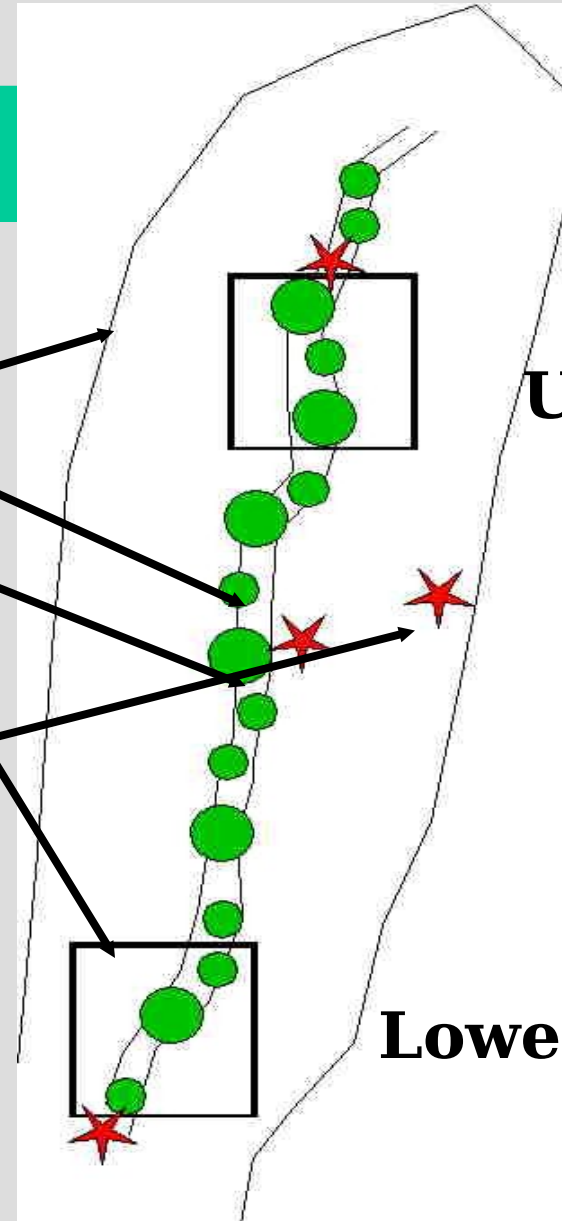
Trees/Shrubs

Vegetation Plots

Soil Moisture Plots

**Vegetation monitoring:
six drainages**

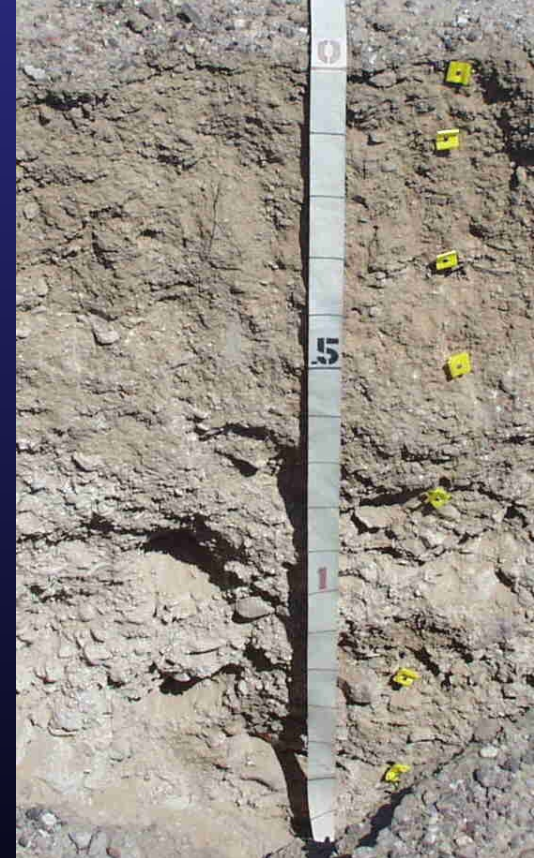
**Soil moisture
monitoring:
drainages** **two**



Upper Site

Lower Site

Pilot Project Approach



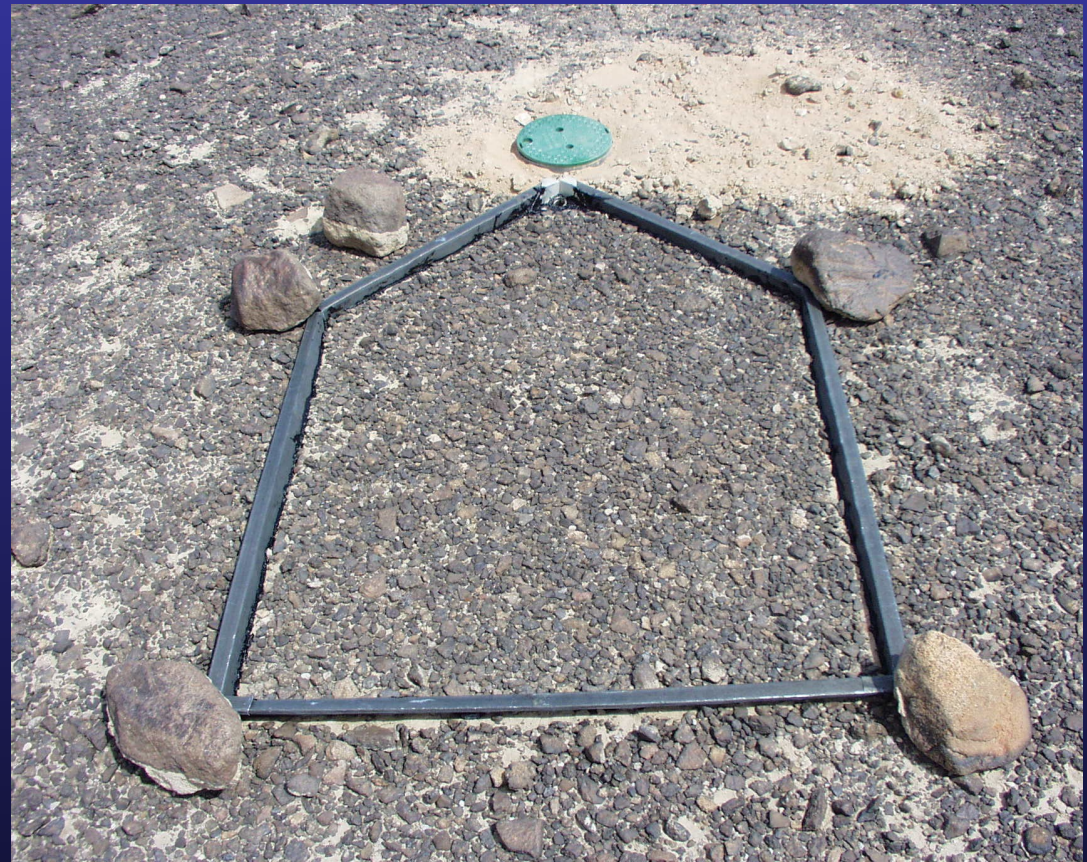
**Soil
Characterizati
on**

Pilot Project Approach



**Monitoring
Soil
Moisture**

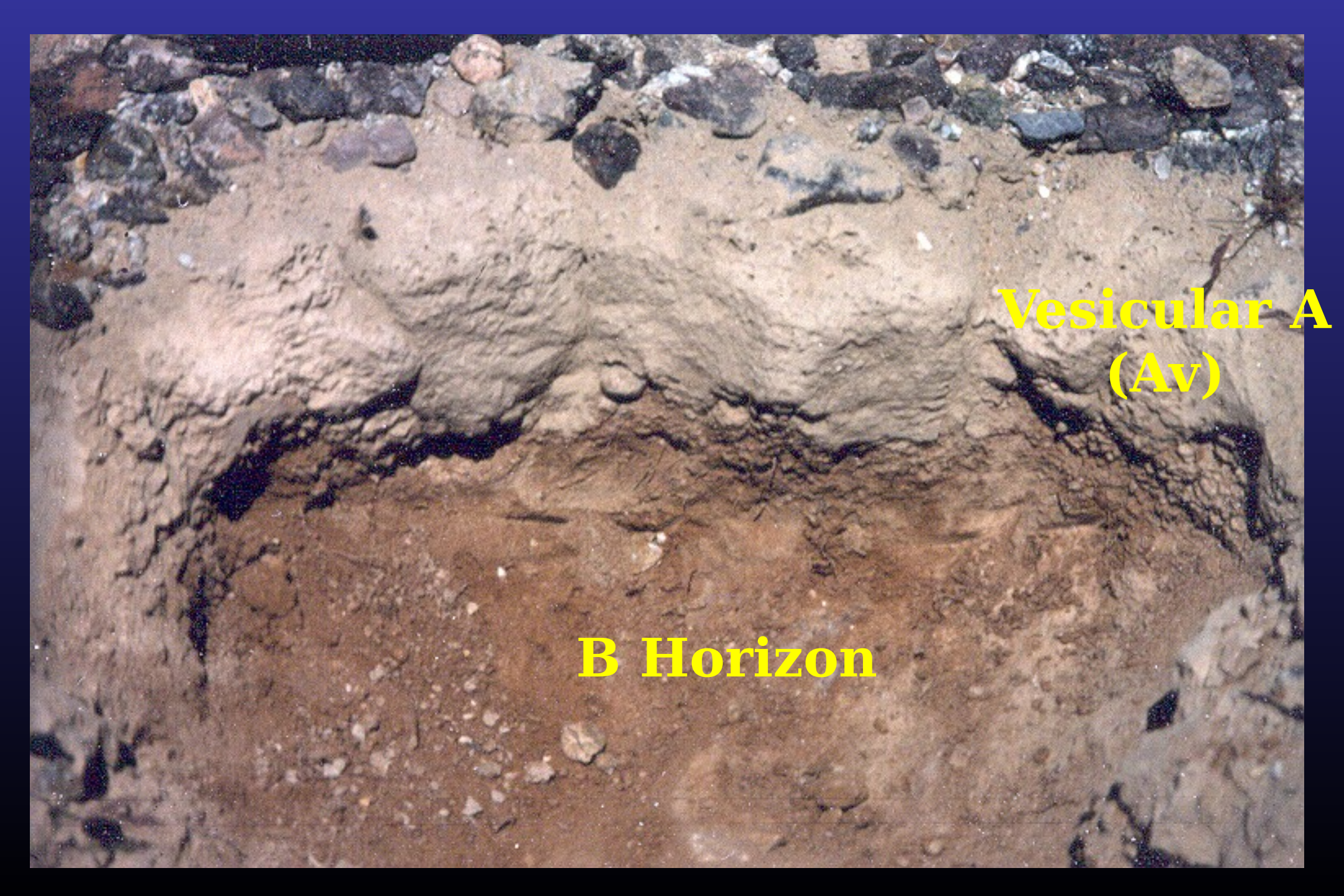
Pilot Project Approach



**Monitoring
Surface Water
Runoff**

A close-up photograph of a desert pavement surface. The surface is composed of numerous small, dark brown to black, angular clasts (pebbles and stones) of various sizes, ranging from a few millimeters to about a centimeter. These clasts are densely packed and interlocked, creating a rough, textured surface. The background is a solid, deep blue color.

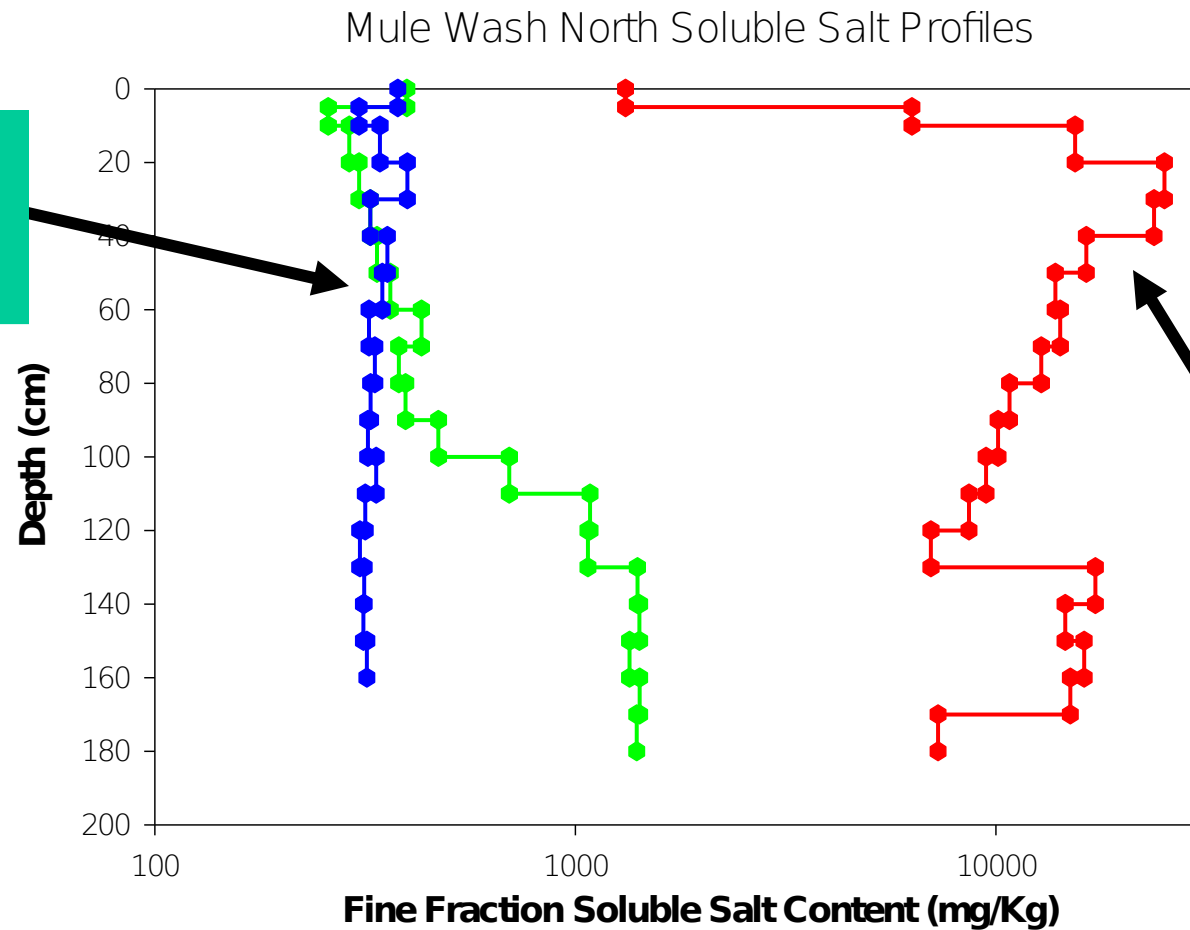
Desert Pavement: Interlocking Pavement Clasts

A photograph of a soil profile. The top layer is a light brown, sandy soil with some small, dark, irregular clumps. Below this is a darker, reddish-brown soil layer. The boundary between the two is somewhat irregular. The top of the profile is covered with a layer of dark, jagged rocks and debris.

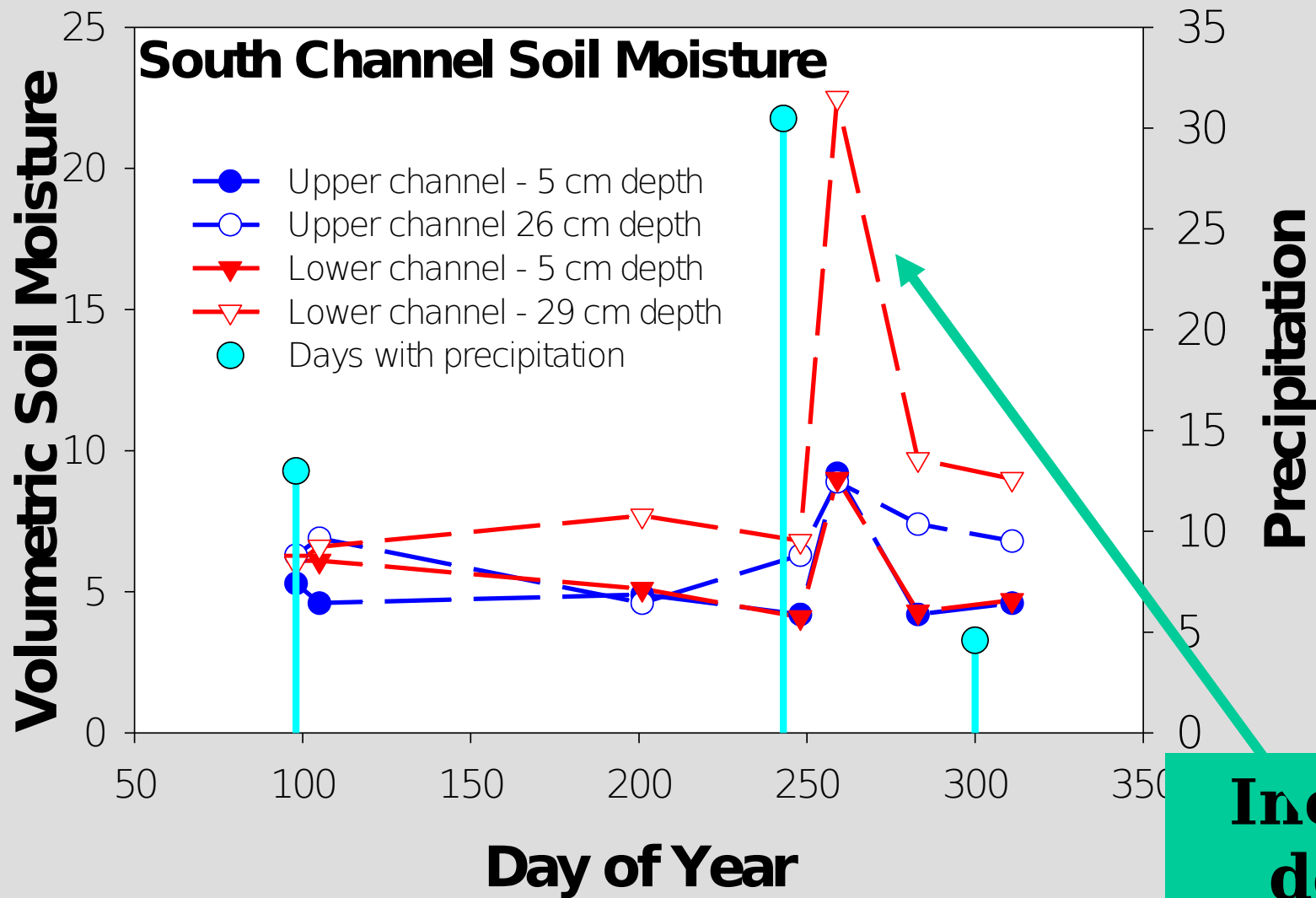
**Vesicular A
(Av)**

B Horizon

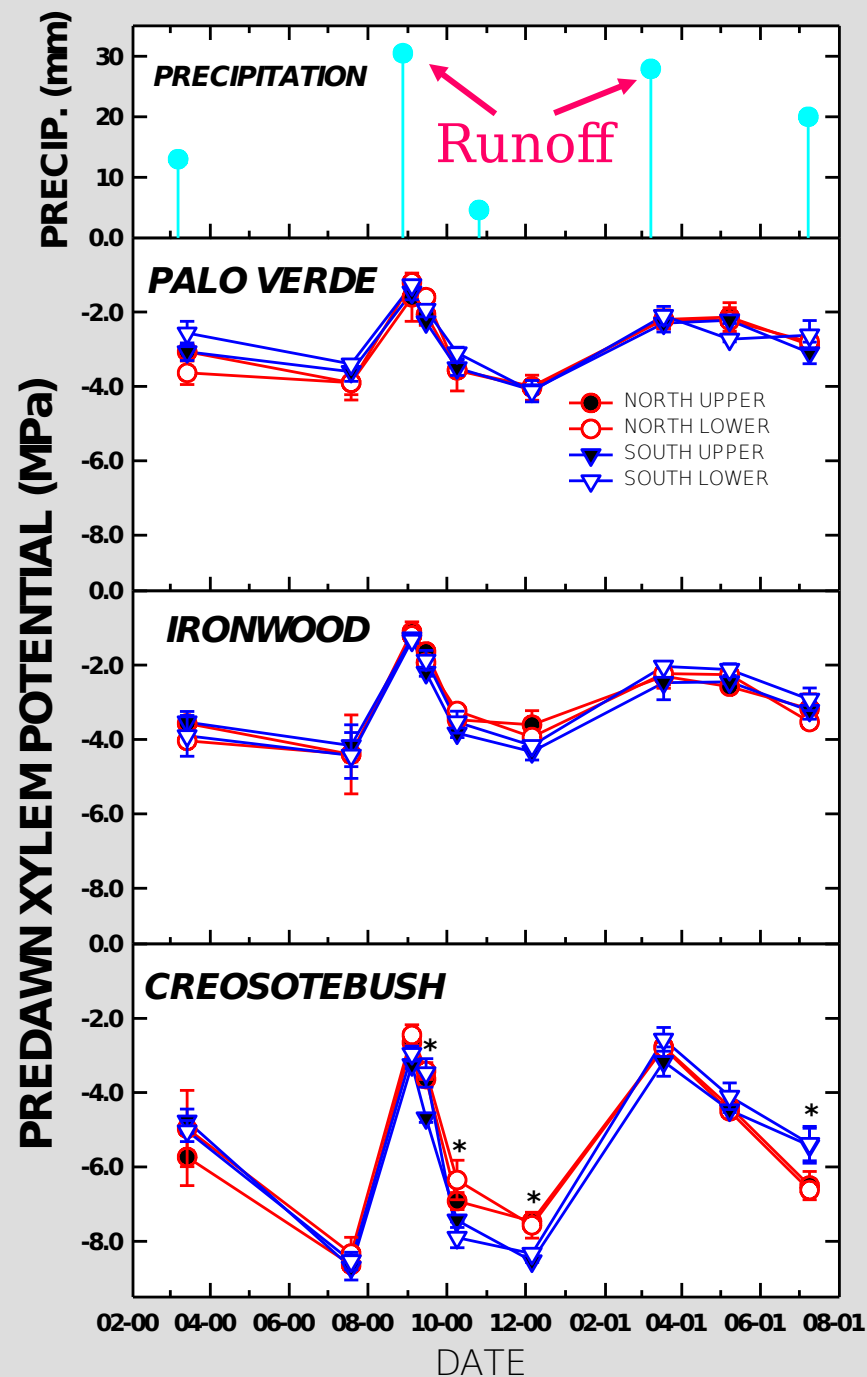
Channel Soil



Pavement Soil



**Increase in
deep soil
moisture
following
runoff event**



Measuring Plant Water Potential

Observations:

- Water potentials for palo verde and ironwood indicate deep (>1.5 m) soil water
- Creosote responds to shallow (<1.5m) soil water

Pilot Project: Results

- ❖ Results indicate that the most *critical source* of surface runoff is infrequent large storms (~6 to 18 months/storm)
- ❖ Integrity of soil surface critical for runoff
- ❖ Soil moisture in upper 1 m cannot account for tree activity
- ❖ Trees accessing locally stored soil water, probably 2-5 m deep (vadose zone, NOT groundwater)

Land Management Concerns

- ❖ Initial results indicate that *critical source* of plant water is surface runoff from infrequent large storms
- ❖ Integrity of soil surface critical for runoff
- ❖ Decrease in runoff (i.e., soil degradation from military activities and/or decrease in frequency of large storms will result in a reduction in biomass and

Recommendations

- ❖ Monitoring vegetation along first-order channels (and higher?) can serve as an indicator of ecosystem status
- ❖ Evaluation of soil water/surface hydrology critical for monitoring ecosystem health
- ❖ Knowledge of soil and geomorphic control on the flux of soil water can be used to enhance management strategies

Continuing Project Questions:

- ❖ How does the system respond to different storm events—frontal, convective, and tropical?
- ❖ How can the available monitoring techniques be used to generate a measure of ecosystem health?
- ❖ What is the contribution of the military in affecting ecosystem change?
- ❖ Approach for use at installations in other dryland areas needs to be evaluated